Physics Workshop Review
(Physics Results for Moriond)

DØ Collaboration Meeting

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27th February 2004

Dataset, quality, tools

- Full ~200 pb^{-1} July 02 - Sept 03 dataset reprocessed, fixed, skimmed and analysed
  - This was a huge effort/achievement that should be recognised/celebrated!
- Main improvements since Lepton-Photon-03:
  - Tracking efficiency
  - Jet quality
  - Data quality by LBN and not by Run (for some categories?)
  - Fraction of bad quality data is decreasing
    - but 1-3% times N detectors and triggers mounts up still!

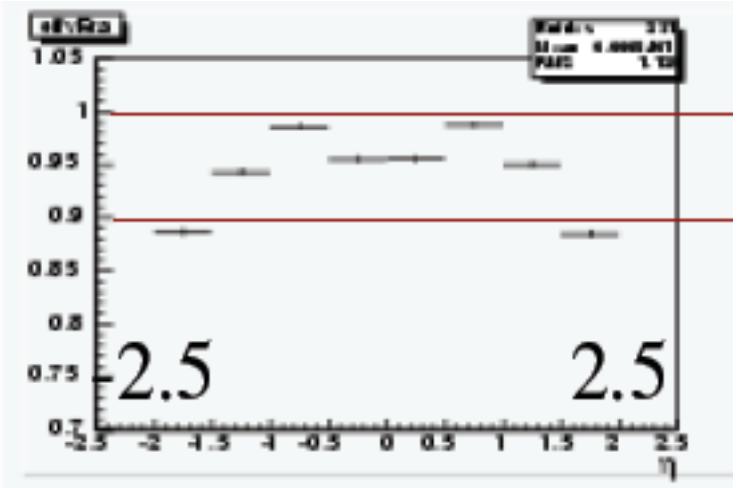
Introductory apologies, excuses, complaints

- Very large number of people working very hard
  - Can't do justice to all their efforts in 35 minutes
- I decided not to mention names associated with each plot/result
- Not every talk/result explicitly mentioned
  - Considerable duplication in some areas (esp. W+jets [esp. with B-tag])
- Still very early days in DØ physics analysis:
  - Important aspect of "physics analysis" is to learn about/improve the detector/trigger/reco/MC:
  - We heard many pleas from online and ID people for more feedback from physics analysers
- Concentrate mainly on results expected for Moriond

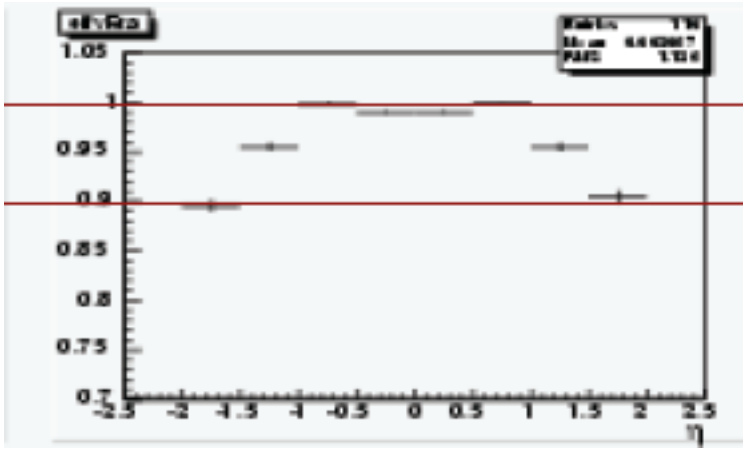
Tracking Improvements

- Efficiency:

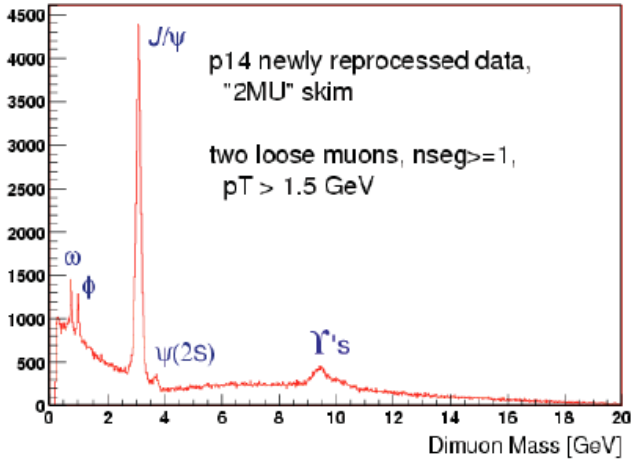
from μ+jet data

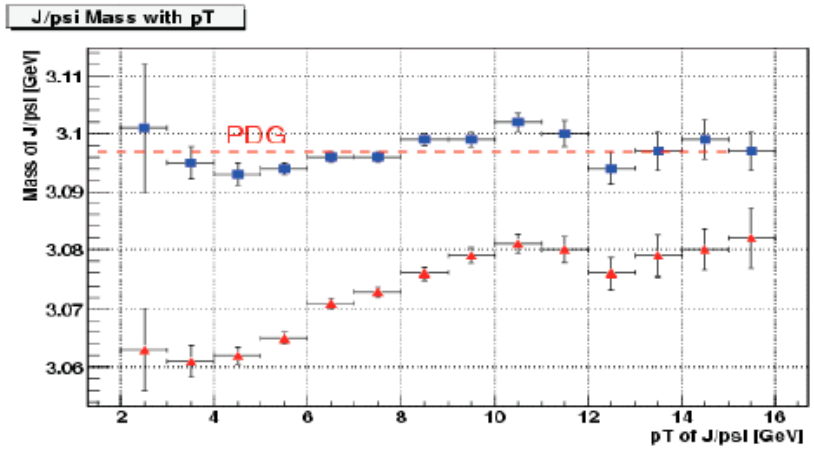


Monte Carlo



- Momentum scale: tune B field, material, alignment





Overview

Detector, objects	Experimental signature, physics topic
Tracks: (μ for trigger & B-tag)	(Semi-)exclusive B decays (lifetimes, mixing, branching ratios)
Muons:	$\mu^+\mu^-$ final states: Υ, Z, high $m_{\mu\mu}$ $\mu(\mu)$+MET: $W\rightarrow\mu\upsilon$, exotics (cross-section•Branching ratio: measurements and/or limits)
+ Electrons:	ditto, plus: eμ+MET, Afb(ee)
+ Photons:	Wγ, $\gamma\gamma$+MET

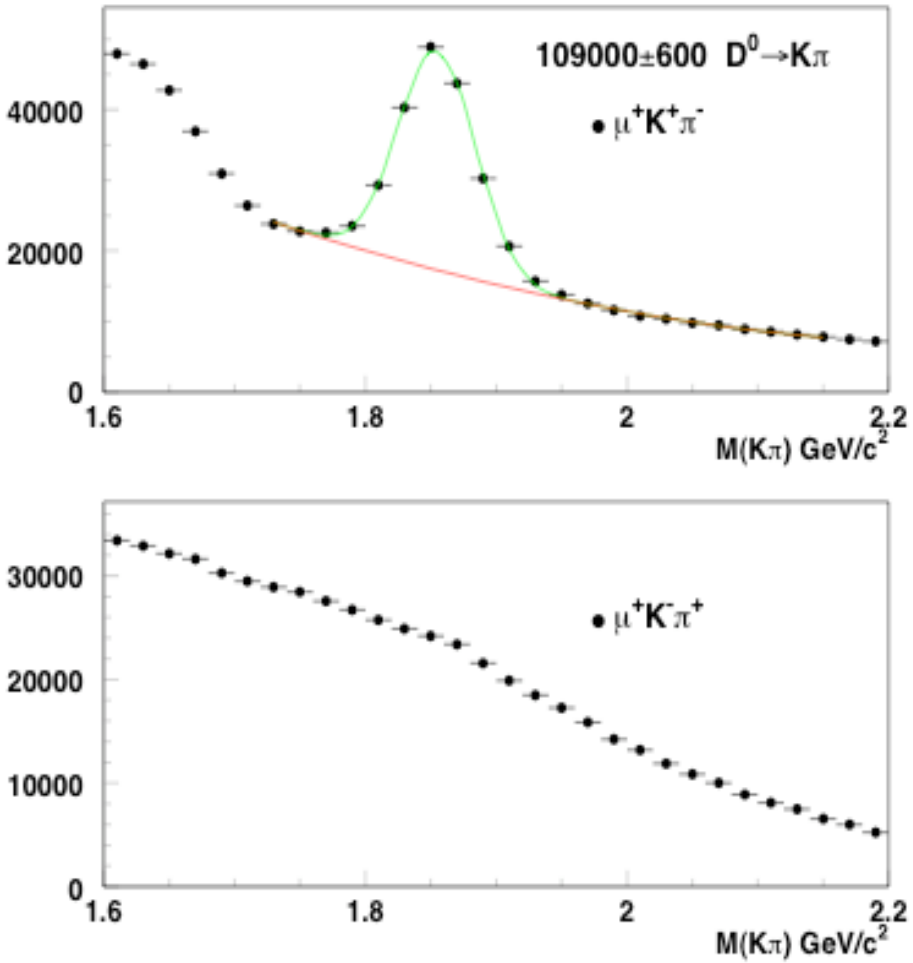
Overview (continued)

Jets:	$d\sigma/dp_T$, $d\sigma/dm_{jj}$, $tt \rightarrow 6jets$, j(j)+MET
Leptons+Jets(+MET):	W/Z + jets (QCD, top, H) LQ, ….
+ B-tag: (lifetime and soft lepton)	ditto!

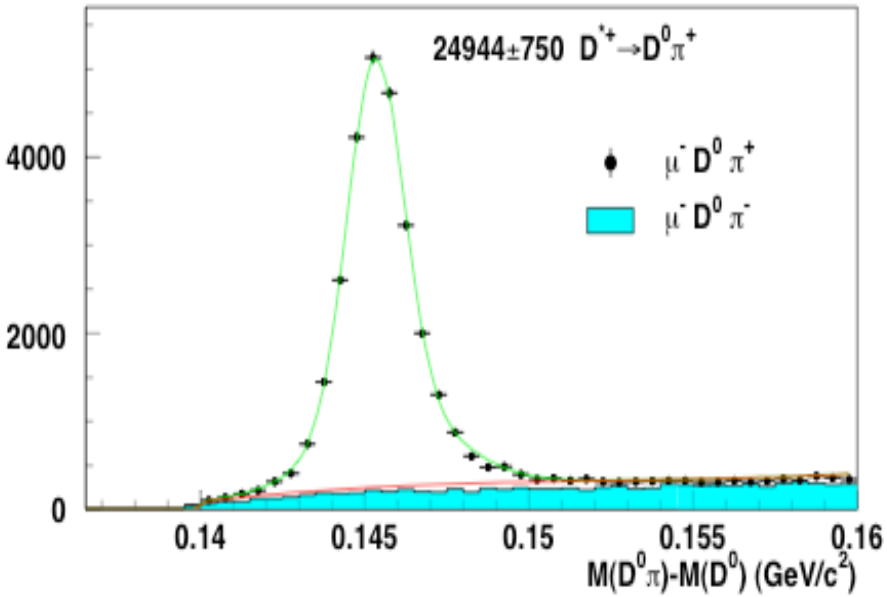
Measurements with B Hadrons

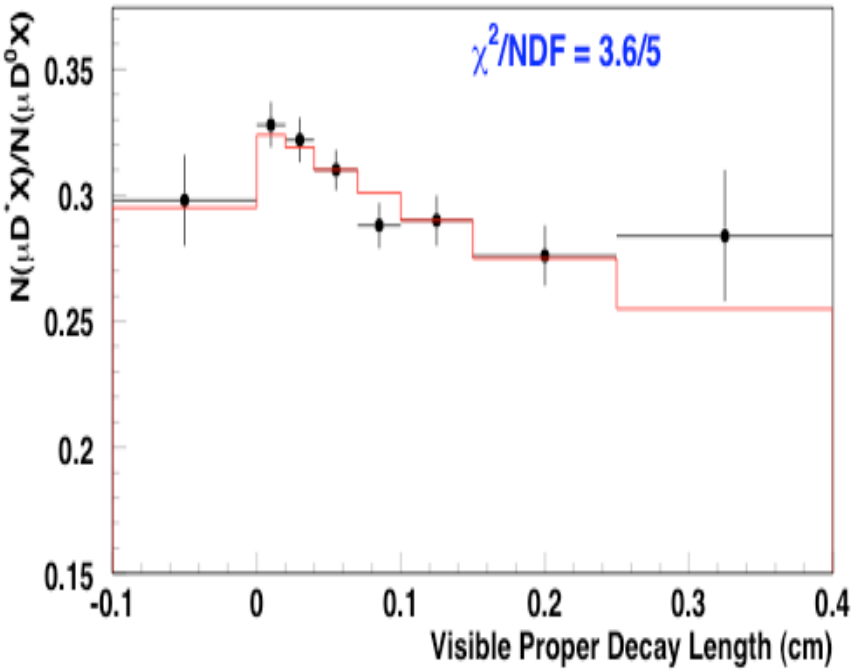
- Huge samples of B hadron decays in 250 pb-1

$B \to \mu\bar{\nu} D^0 X$



- D^0 combined with additional π^+ to give D^{*+}





Measurement of $\tau(B^+)/\tau(B_d)$

D^* sample: ~84% B^0 ~15% B^+ ~2% B_s

D^0 sample: ~16% B^+ ~82% B^0 ~2% B_s

- Precise measurement of τ^+/τ^0 is obtained;

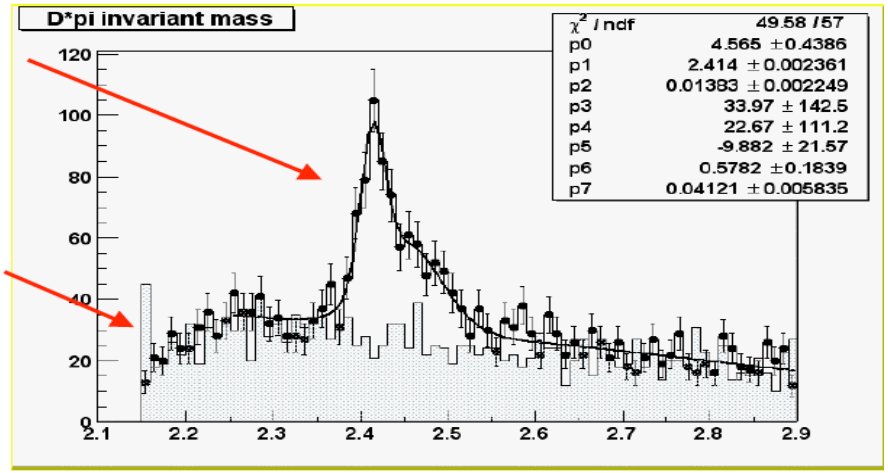
$$k = 0.094 \pm 0.021(stat) \pm 0.020(syst)$$

- Consistent with world average value $k = 0.085 \pm 0.017$;

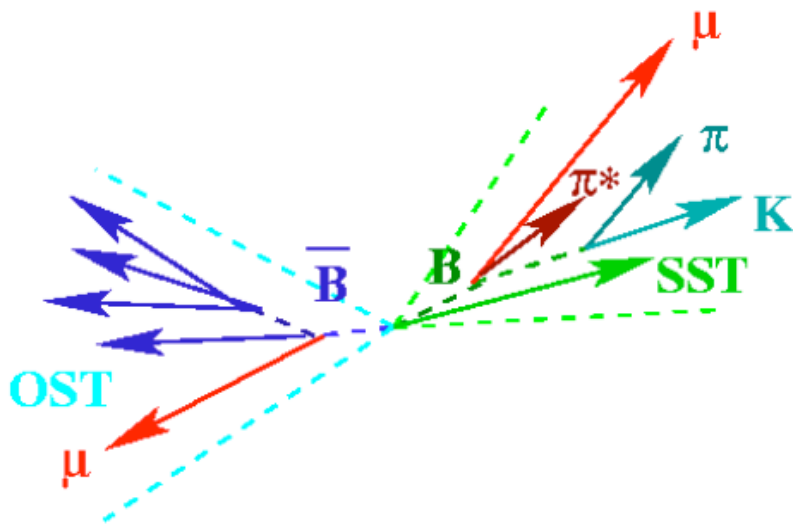
- See B -> D**μ X signal
  - 457 +/- 44 events
  - No signal for wrong sign combination

- Two merged resonances
  - $D^0_1(2420)$
  - $D^{*0}_2(2460)$

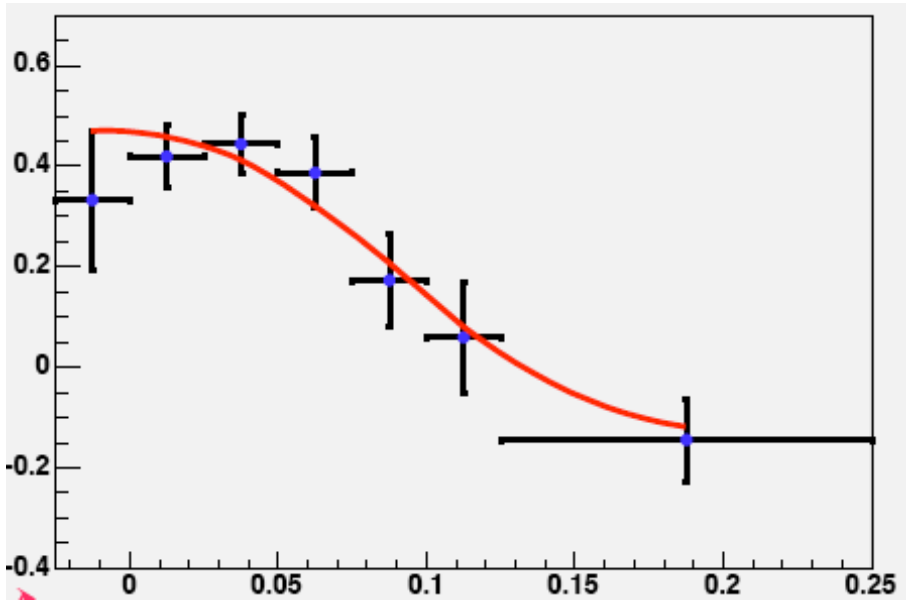
- D* reflection for wrong sign combination



B^0_d Mixing Using Same Sample



$$A_i = (N_i^{\text{non-osc}} - N_i^{\text{osc}}) / (N_i^{\text{non-osc}} + N_i^{\text{osc}})$$



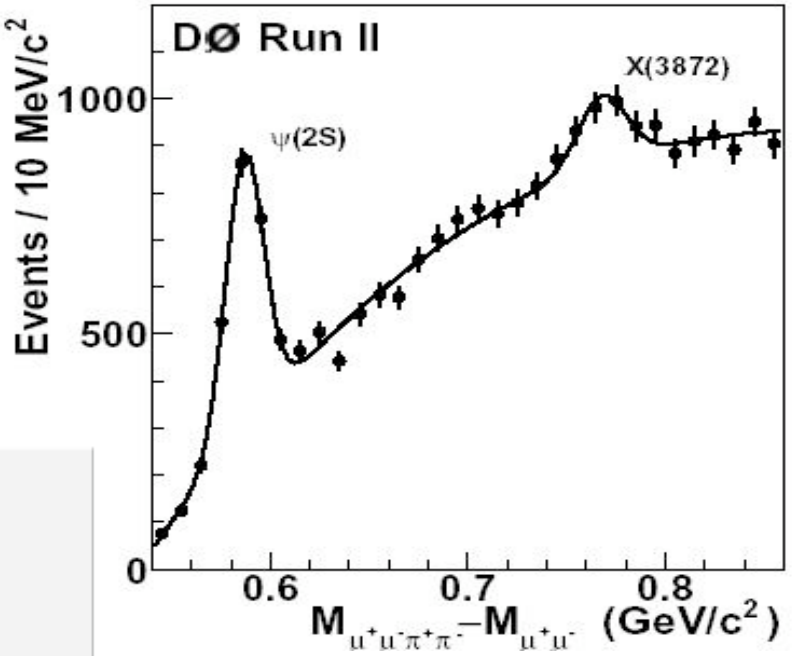
Visible Proper Decay Length

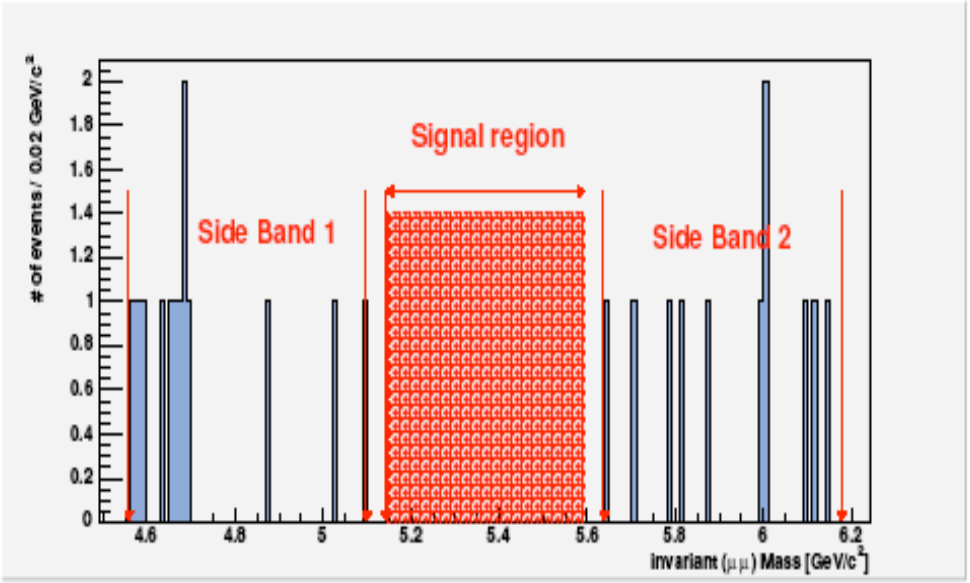
- Tag flavour at production
  - Opposite Side μ
  - Same Side π
- Careful analysis of D^{*+} sample composition required

Measured Bd oscillations with the OSM
$dM_{OSM} = 0.511 \pm 0.050(\text{stat.}) ps^{-1}$
Measured Bd oscillations with the SST
$dM_{SST} = 0.456 \pm 0.055(\text{stat.}) ps^{-1}$

Other B Physics Measurements

- $X(3872) \rightarrow J/\Psi \mu^+ \mu^-$
  (first run 2 paper?)
- B^0 lifetime from
  $B^0 \rightarrow J/\Psi K^0$





Box not opened!

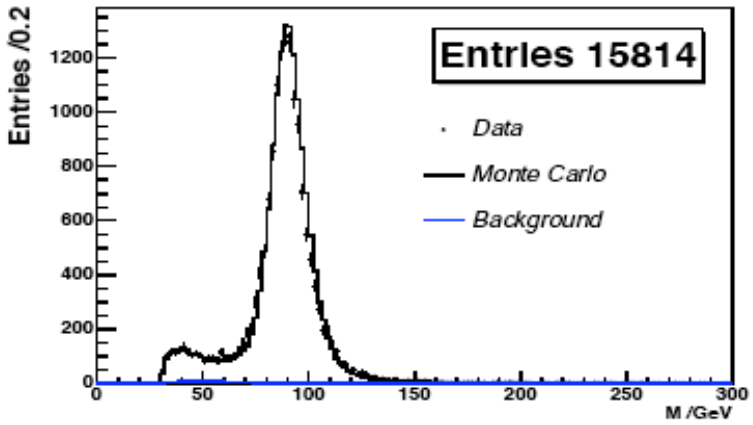
- Sensitivity study for
  $B_s \rightarrow \mu^+ \mu^-$

- Huge potential - v13 has inclusive > 3 GeV trigger at L1/L2

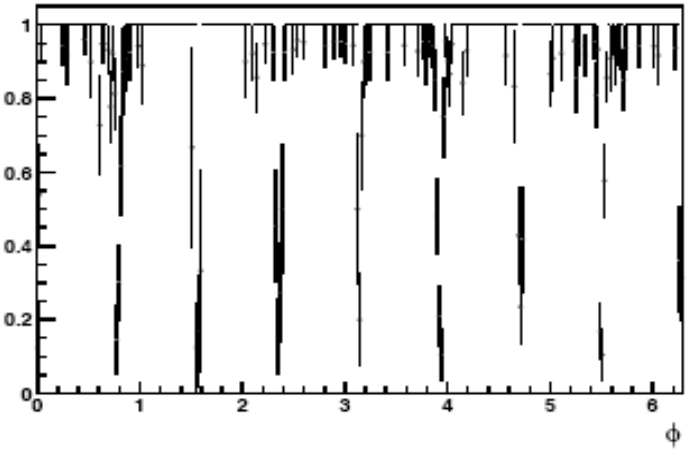
$Z \rightarrow \mu^+\mu^-$

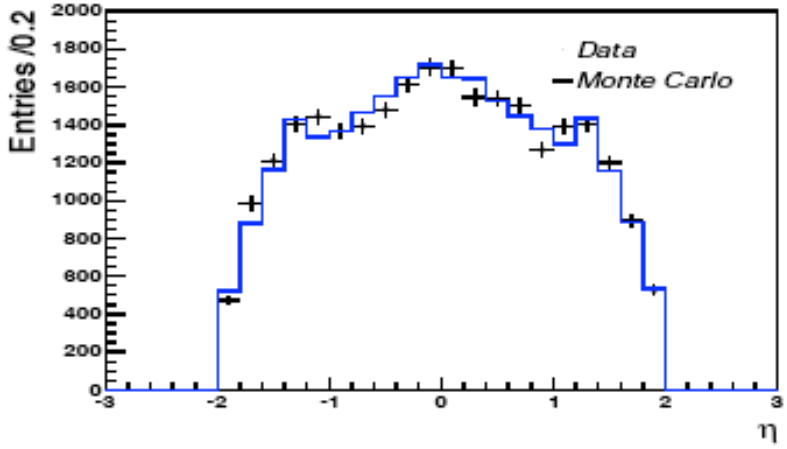
- Public utilities (TMB) to:
  - select candidates
    - total background ~1%
  - measure efficiencies
  - simulate in PMCS

(use .or. of single and di-muon triggers)

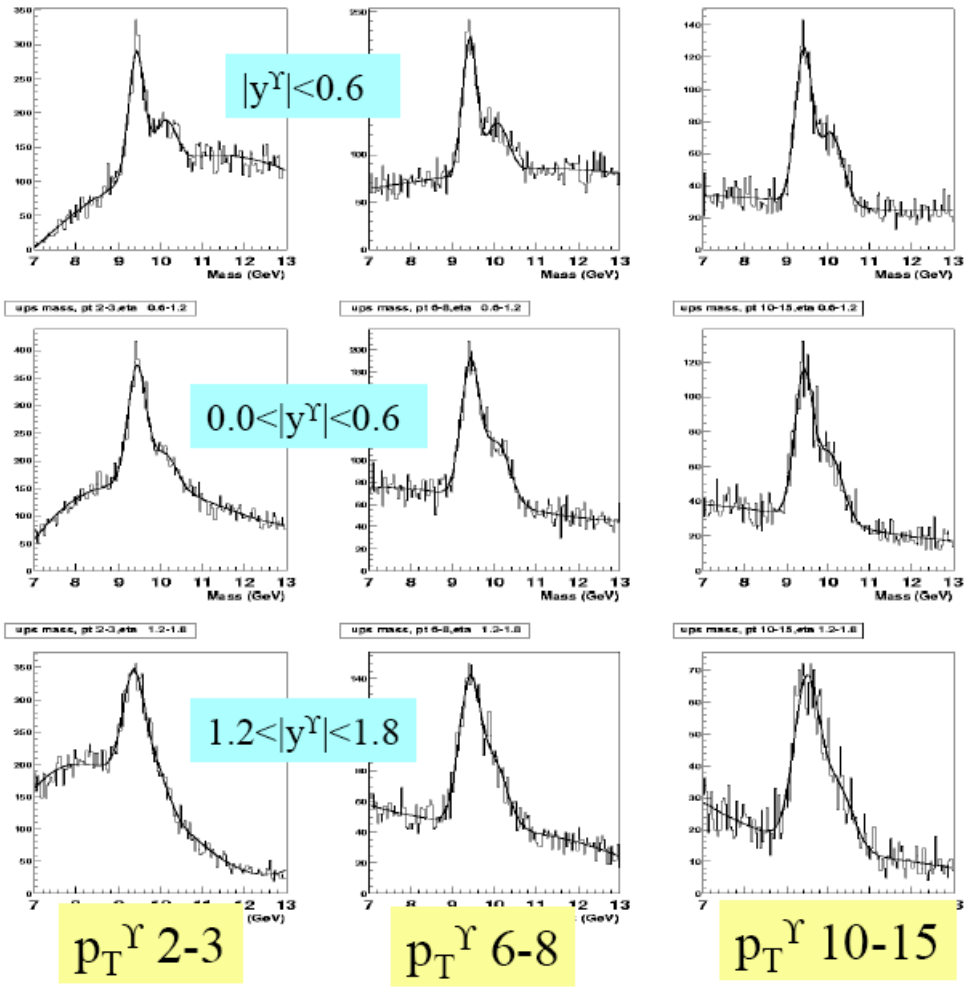


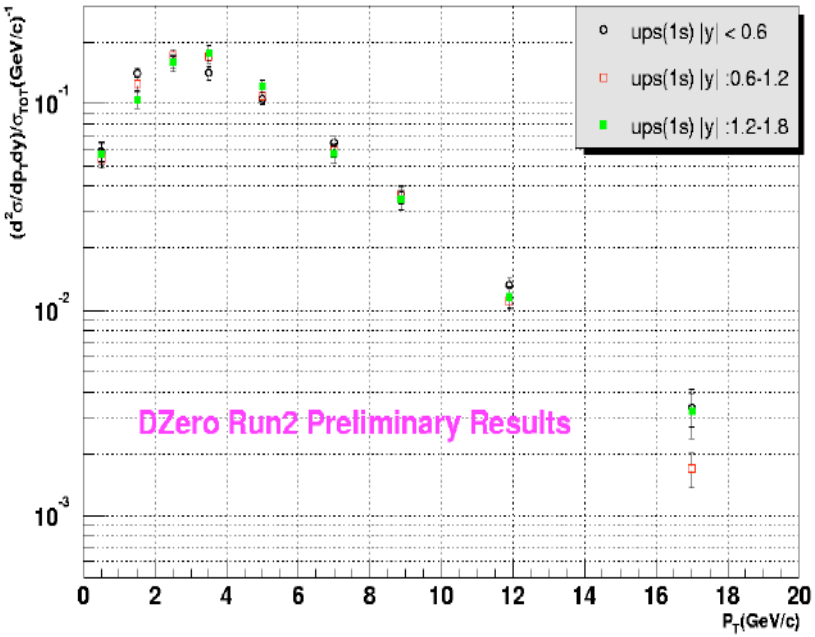
$\varepsilon^{\mu}_{loose}$ (MDT)





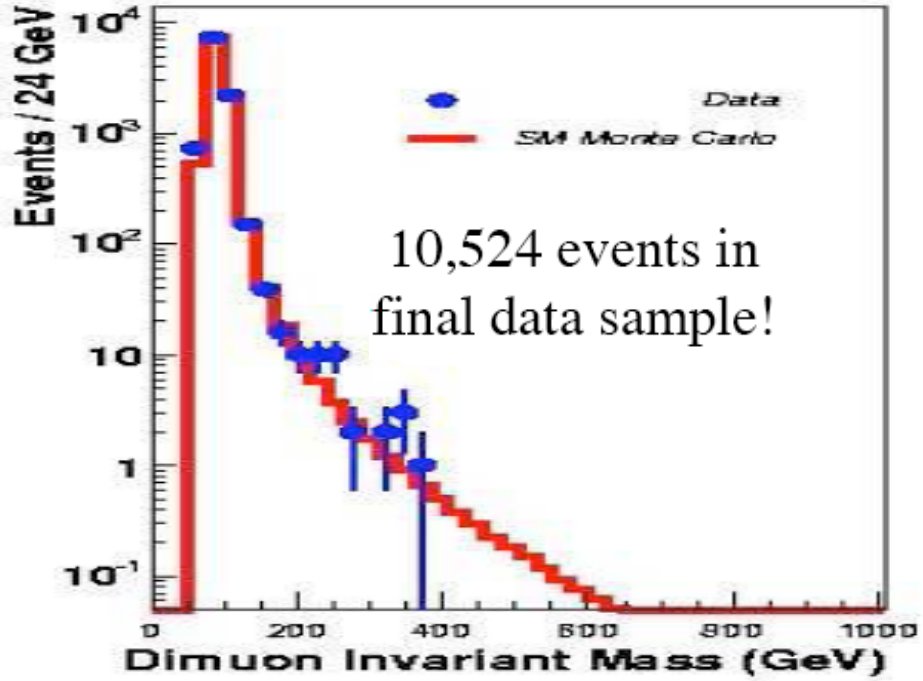
Υ(1S)

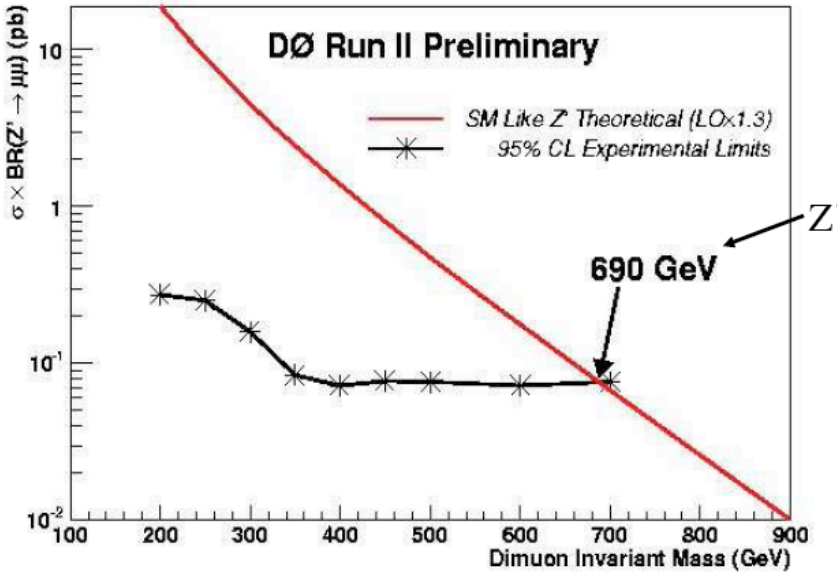

|y^Υ|<0.6
0.0<|y^Υ|<0.6
1.2<|y^Υ|<1.8
p_T^Υ 2-3
p_T^Υ 6-8
p_T^Υ 10-15
Mass (GeV)


ups(1s) |y| < 0.6
ups(1s) |y| :0.6-1.2
ups(1s) |y| :1.2-1.8
DZero Run2 Preliminary Results
(d²σ/dp_T dy)/σ_TOT(GeV/c)⁻¹
P_T(GeV/c)

High Mass $\mu^+\mu^-$

- Sensitive to:
  - Large Extra Dimensions
  - Z'

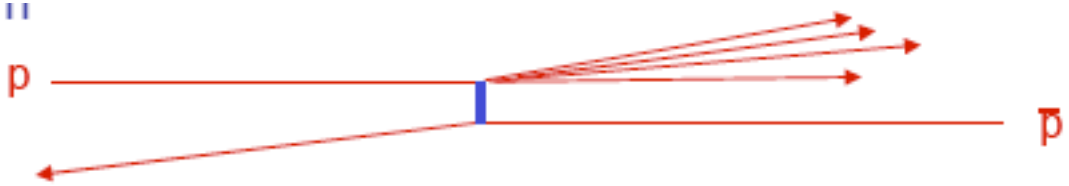


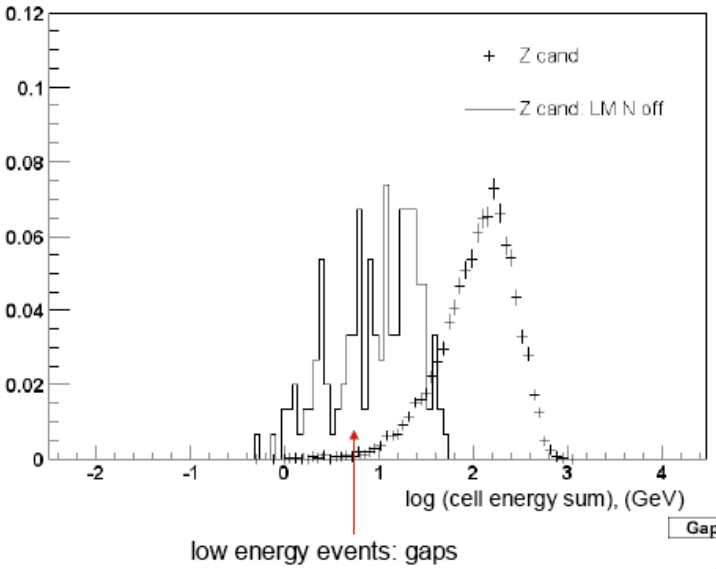


Z' mass limit is 690 GeV!

Diffractive $Z \rightarrow \mu^+\mu^-$

- One proton remains intact

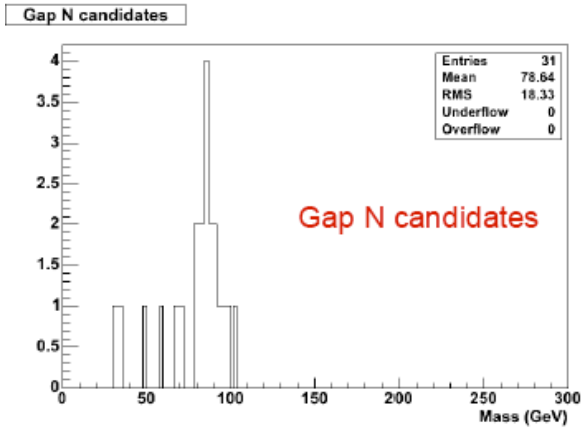


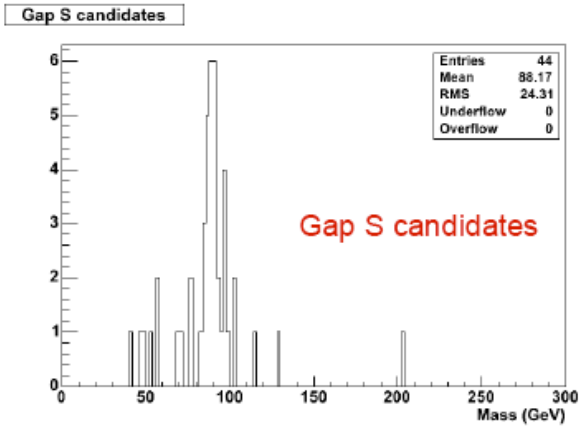


EM and FH layers in region $|\eta| > 2.6$

energy sum for events
with no hit in lumi counter

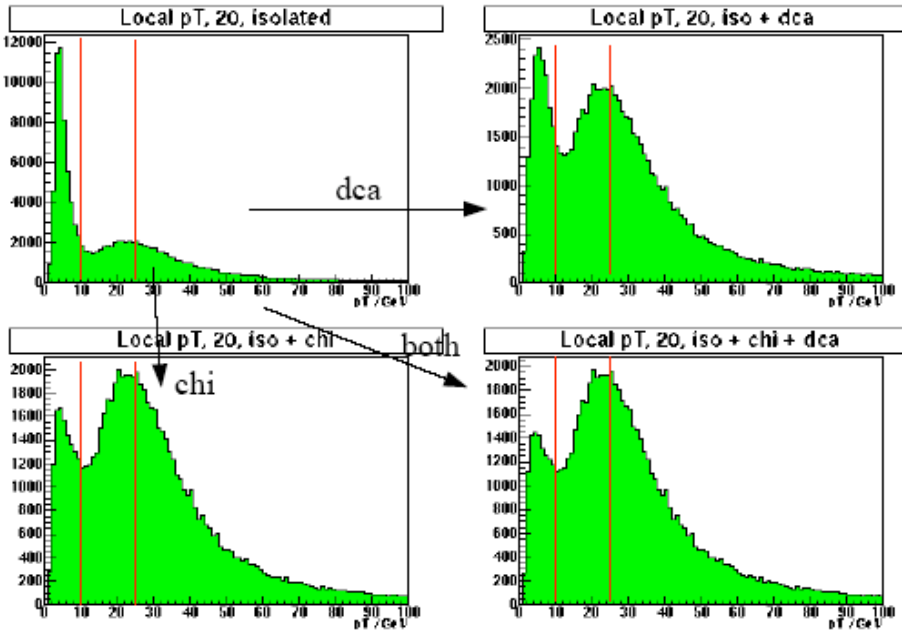
$\mu^+\mu^-$ mass of diffractive candidates



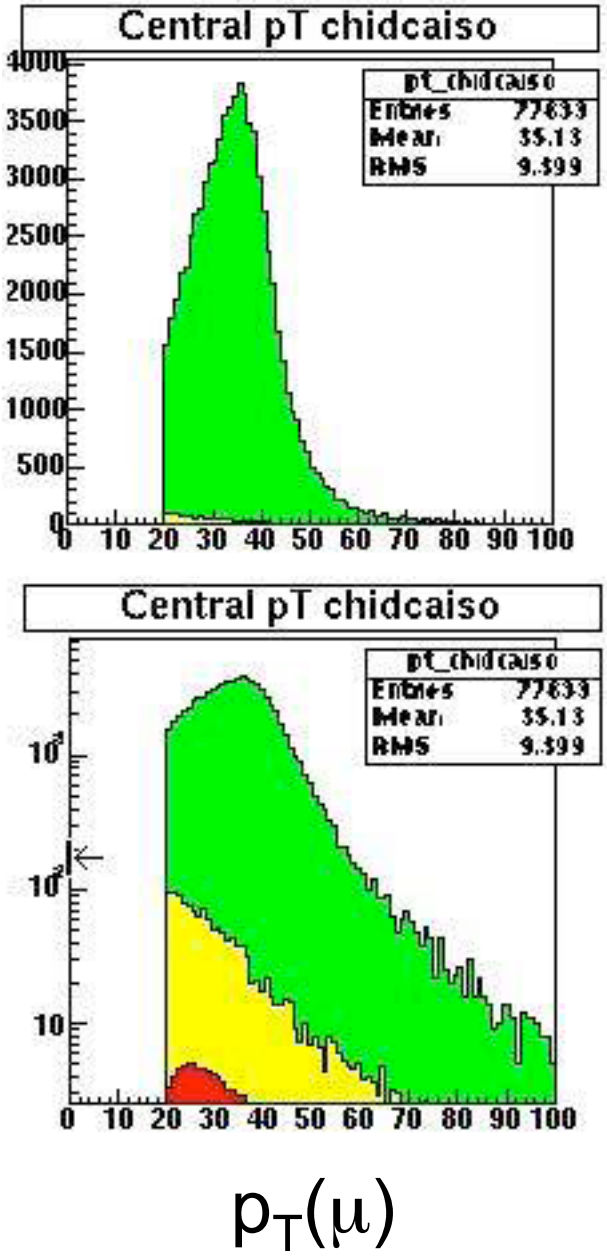


$W \rightarrow \mu\upsilon$

- Decays in flight!



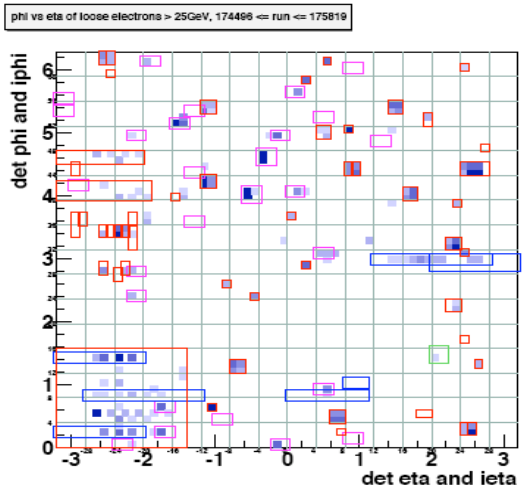
- Analysis uses $Z \rightarrow \mu^+\mu^-$ infrastructure for efficiency measurements and simulation

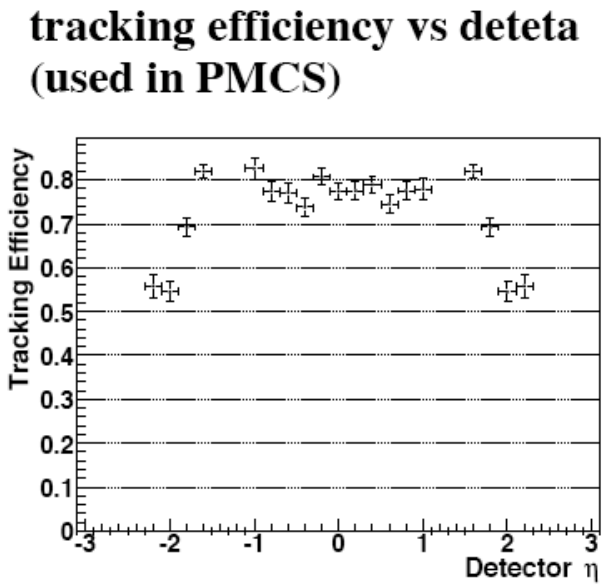


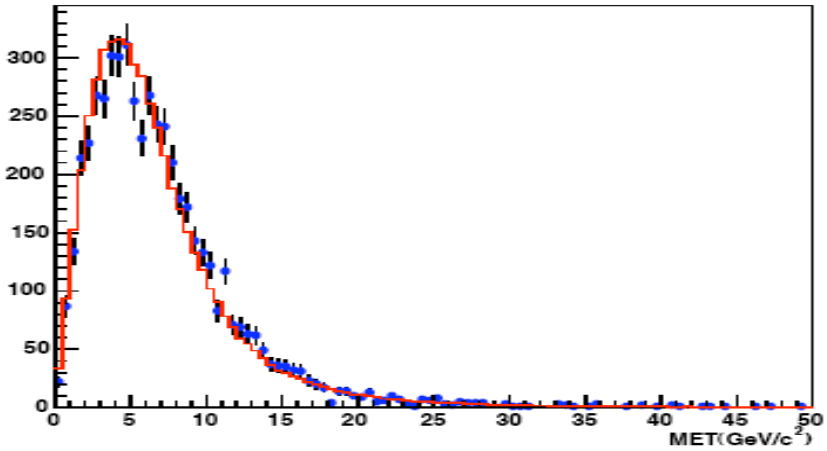
$p_T(\mu)$

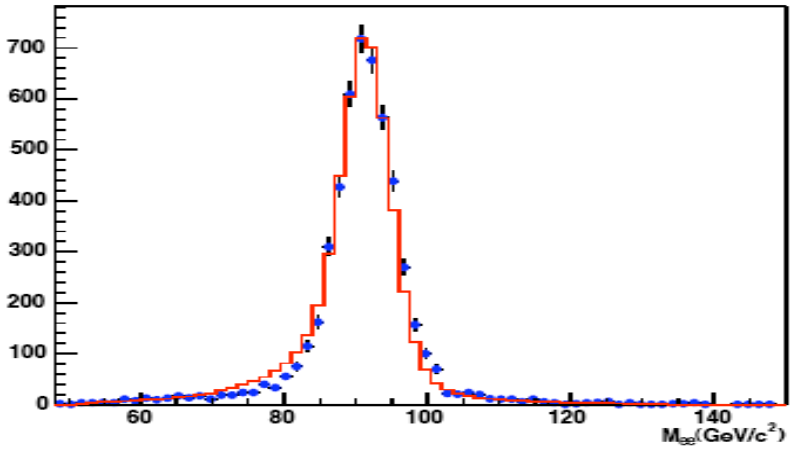
$Z \rightarrow e^+e^-$

- Calorimeter problems





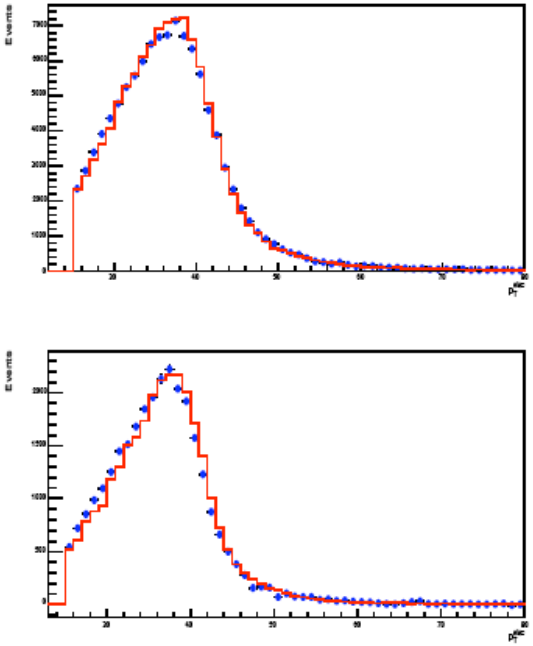




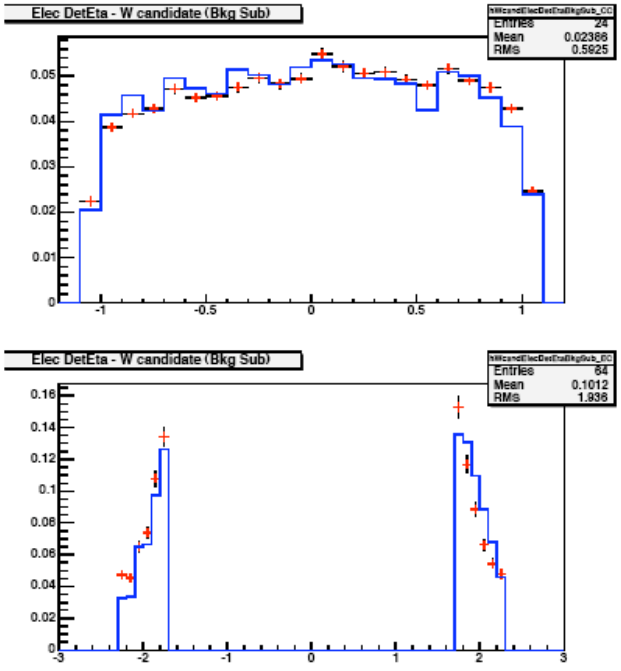
W→eυ

W candidate MC - data comparison

Electron pt, CC and EC



Electron deteta, CC and EC



Z events (at least 1 track)

All: 7636 ± 88
CC-CC: 3910 ± 62
CC-EC: 3001 ± 56
EC-EC: 725 ± 27

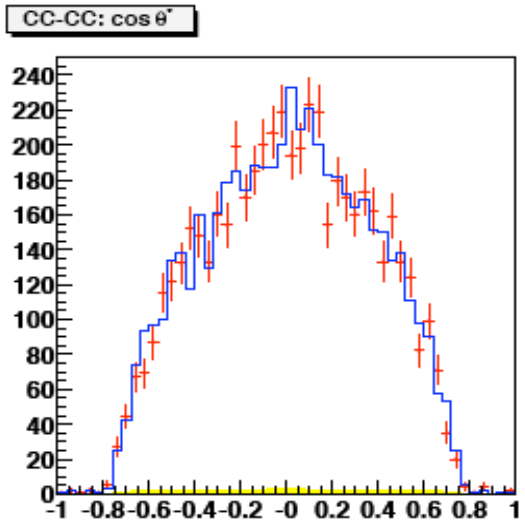
W events

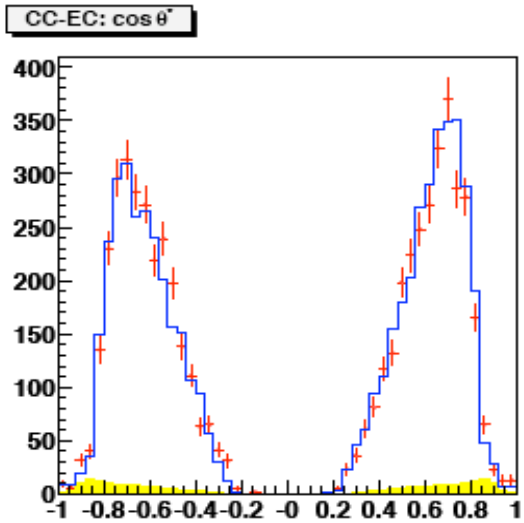
All: 129842 ± 1077
CC: 102472 ± 941
EC: 27370 ± 524

W/Z Ratio(preliminary):

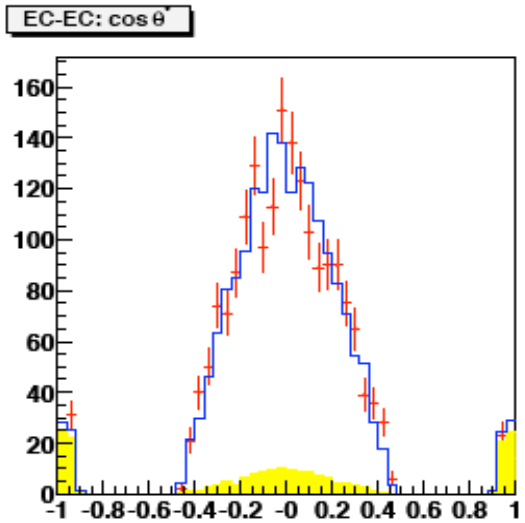
R = 10.15 ± 10 (stat)
compared to: 10.36 ± 31 (Summer 03)

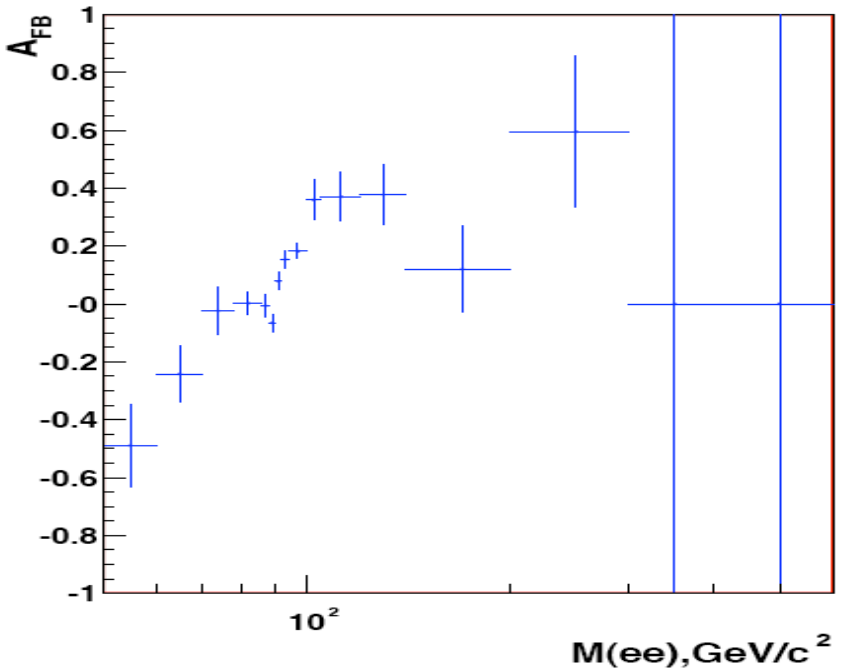
Afb in e^+e^-





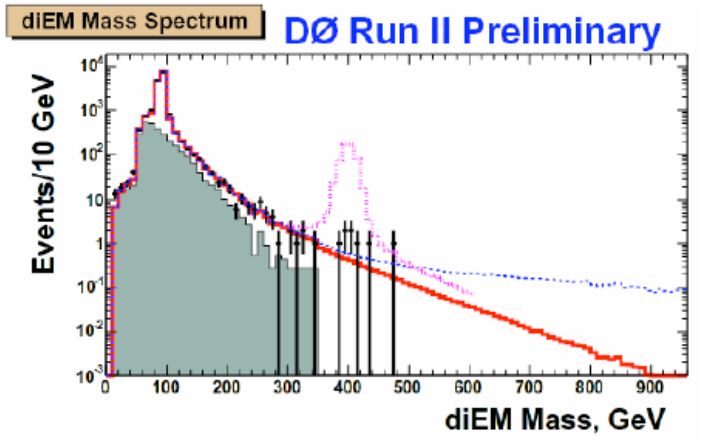
Data/MC $\cos\theta^*$ used for A_{FB}

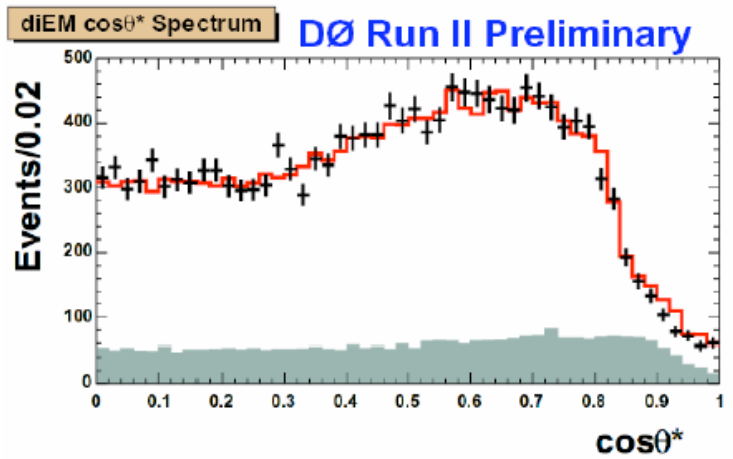


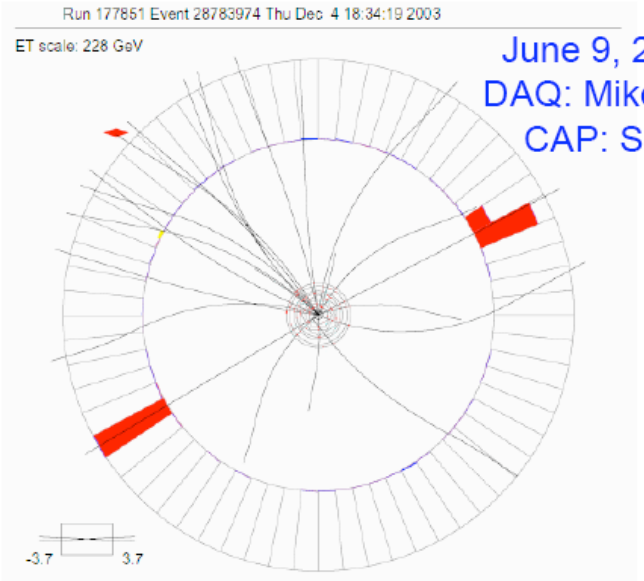


High Mass e^+e^- ($\gamma\gamma$)

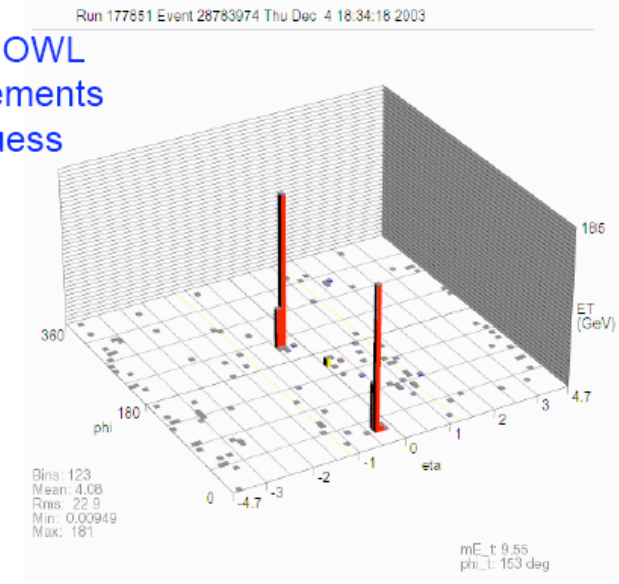
- No data quality cuts applied! Lumi normalised to Z







June 9, 2003 OWL
DAQ: Mike Clements
CAP: Stu Fuess

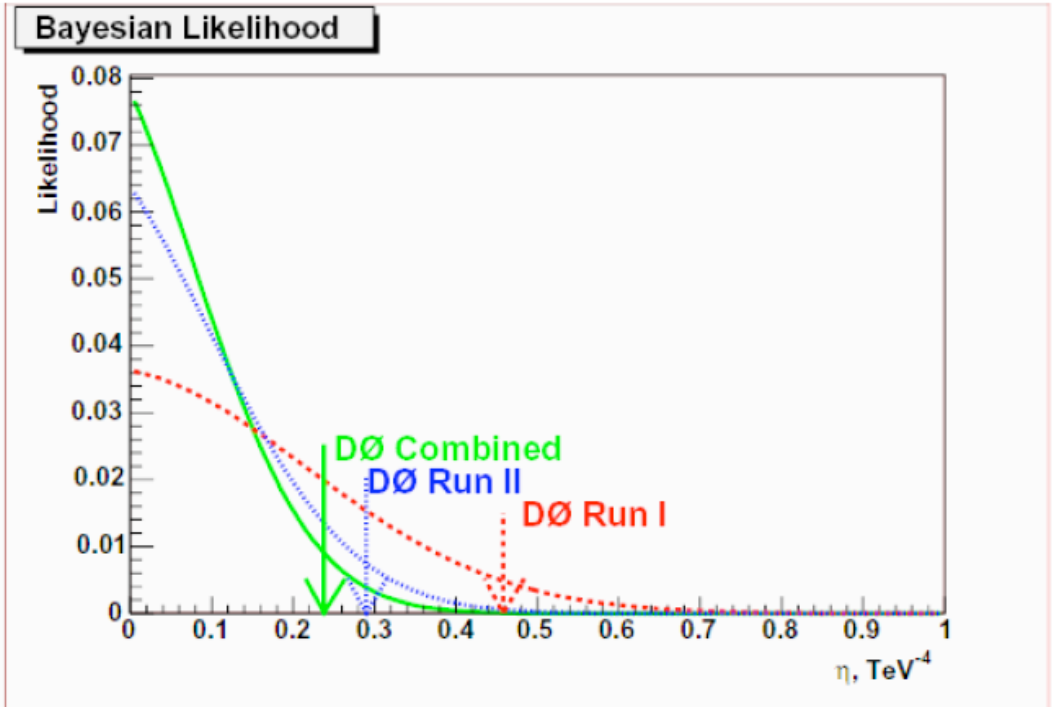


M(diEM) = 475 GeV; $\cos\theta^*$ = 0.01; ME_T = 8.8 GeV

Limits on Extra Dimensions

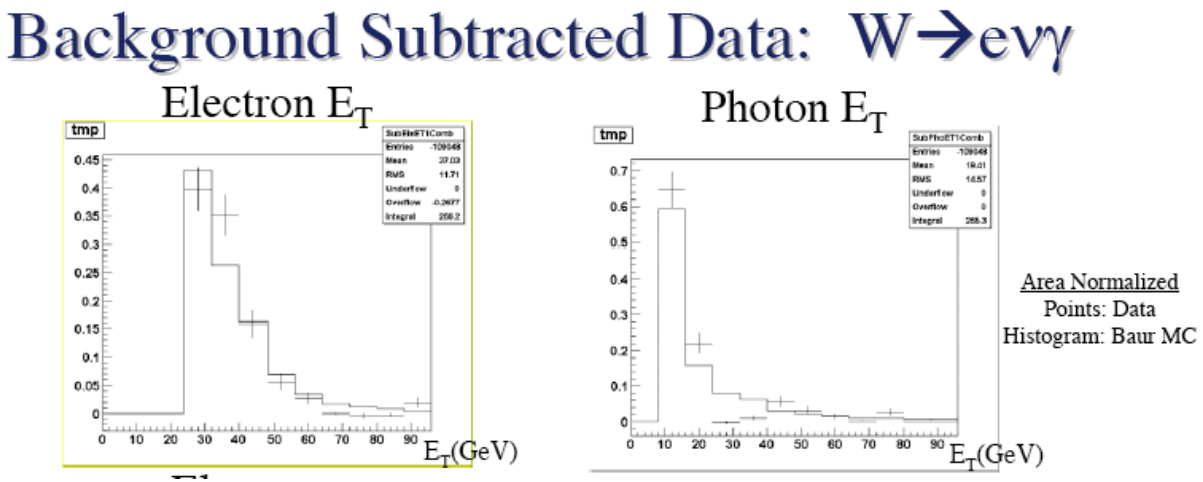
Combination with Run I

- $\eta < 0.24$ (was 0.28), M_S(GRW) > 1.43 TeV
- These are the most restrictive limits to date



- Limits set also on TeV^{-1} scale extra dimensions and Z'

Multi-Boson Final States

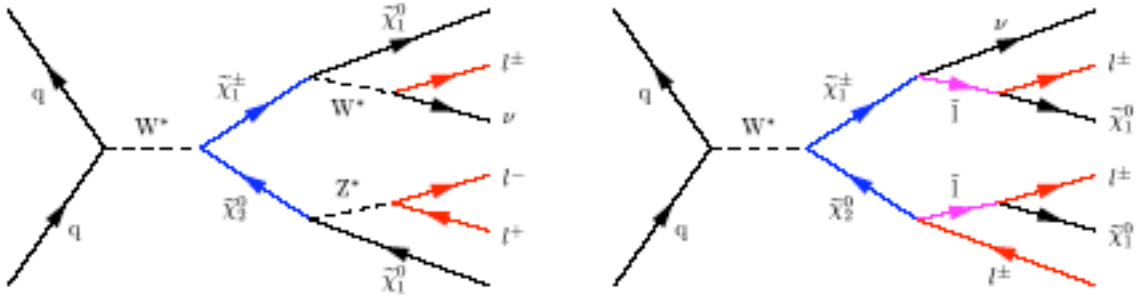


- Also searches for (H→)WW and WZ

channel	data	expected
ee	2	2.7±0.7
eμ	2	3.1±0.4
μμ	5	5.3±0.6

Other searches in multi-lepton final states

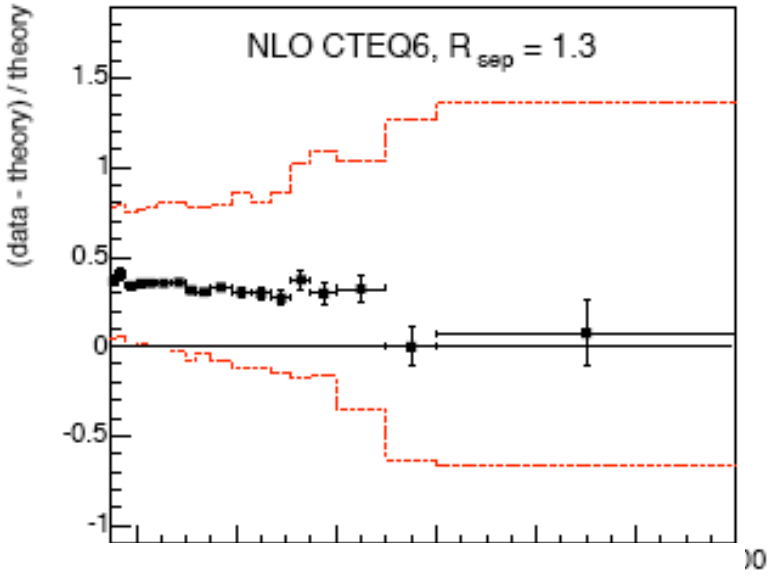
- All possible combinations of e, μ, γ, MET
- Topologies, momenta model dependant

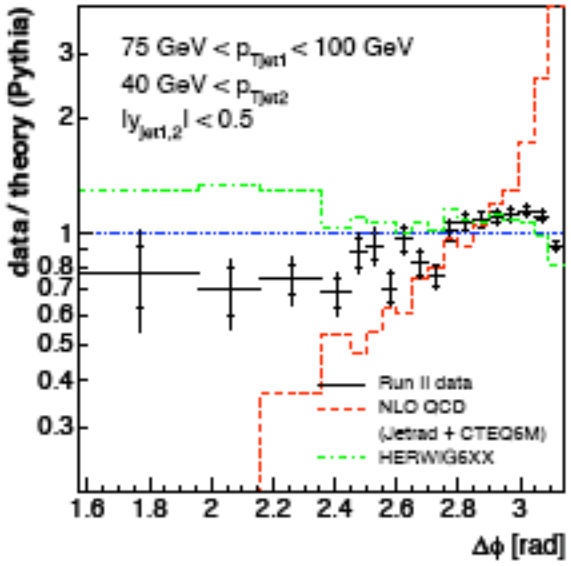


channel	data	SM expected
same sign μμ	1	0.13±0.06
eel	1	0.05±0.25
e μ	0	0.56±0.43

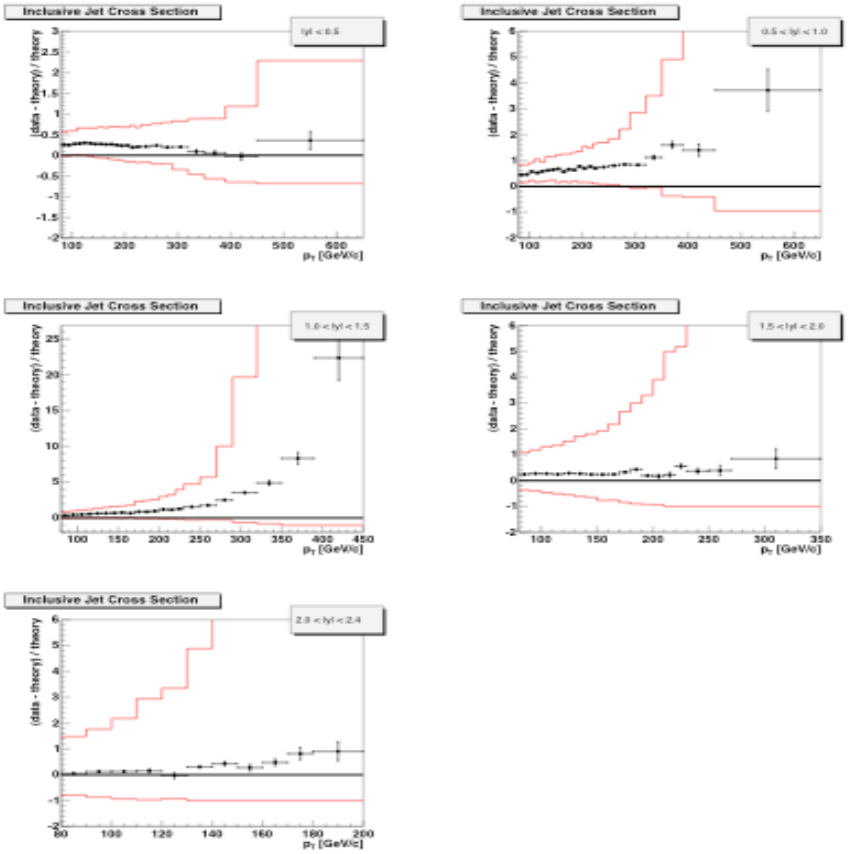
Jets - QCD

Data & theory comparison





(Data-Theory)/Theory

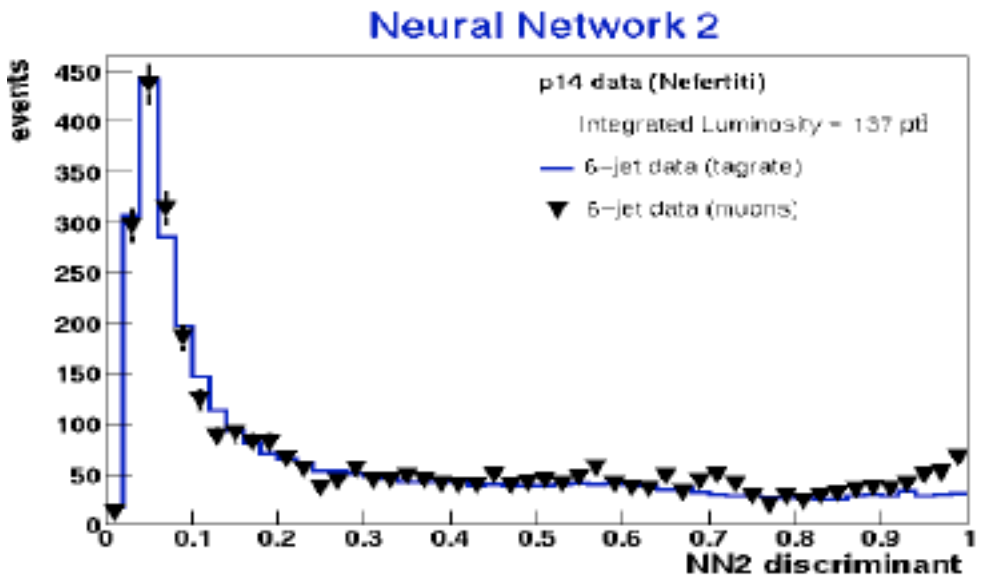


Systematics dominated by JES systematics errors

Other Jet Analyses

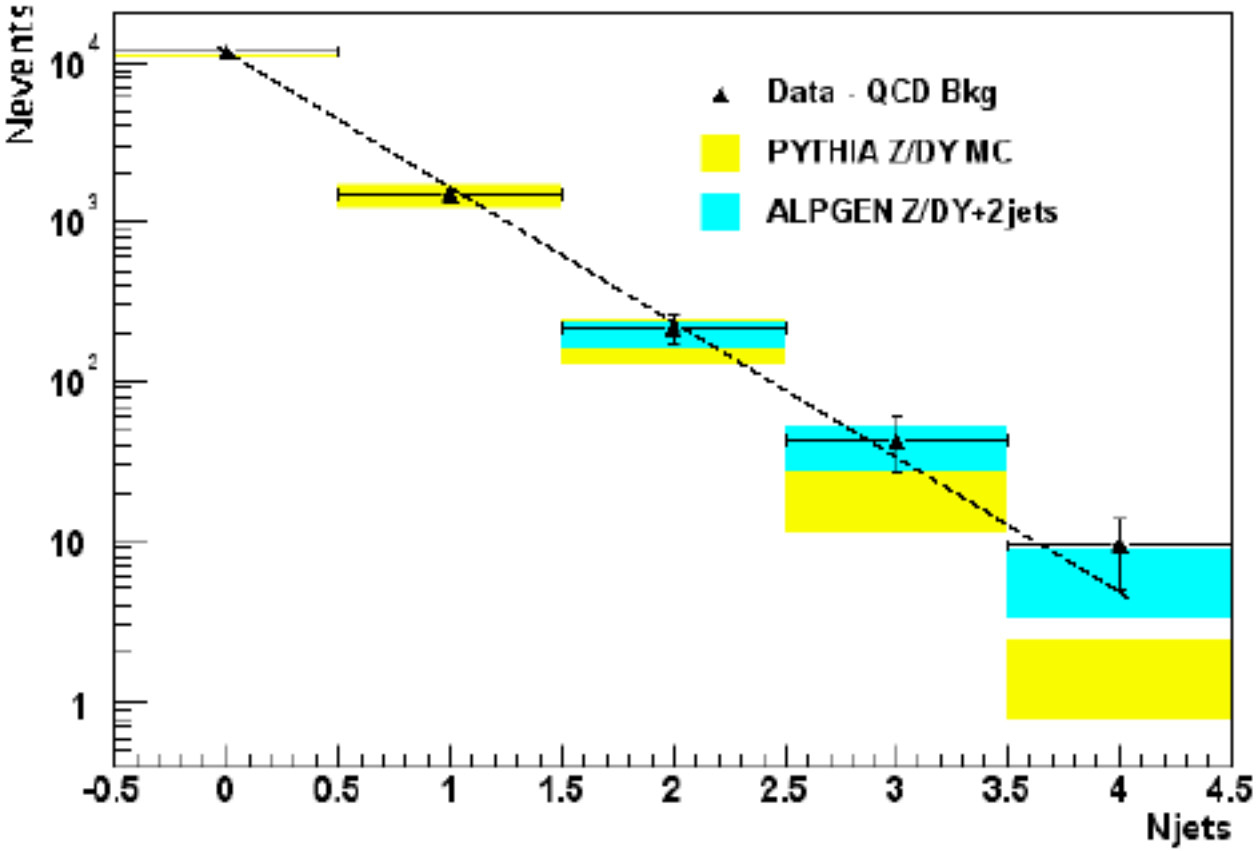
- j(j) + MET: sensitivity killed by JES uncertainty
  (some scope for less conservative treatment of JES)

- tt→6-jets



W and Z + jets

- ALPGEN MC provides better description than Pythia for >2 jets



Top in lepton+jet channel

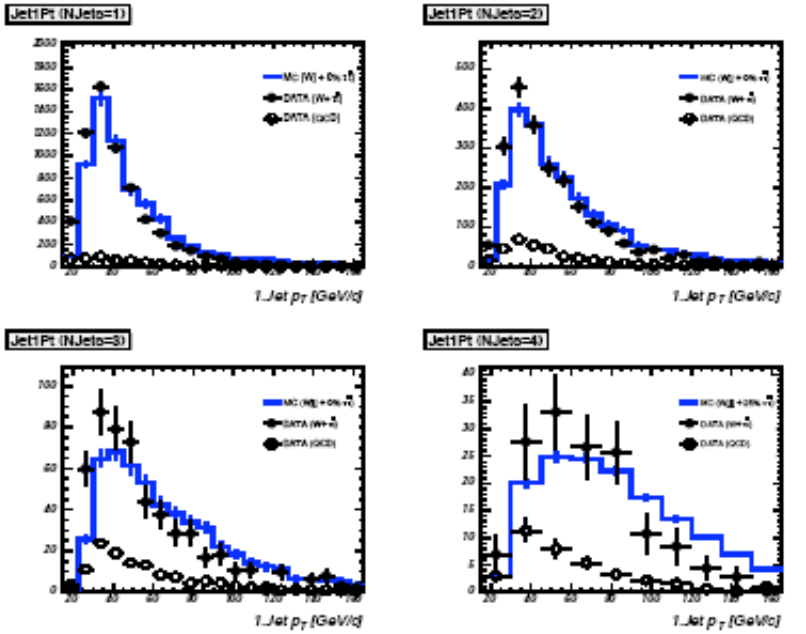
- Isolated p_T^{lept} > 20 GeV
- MET > 20 GeV
- Count jets E_T > 15 GeV
- Form likelihood from kinematic quantities

Data-MC comparisons show discrepancies

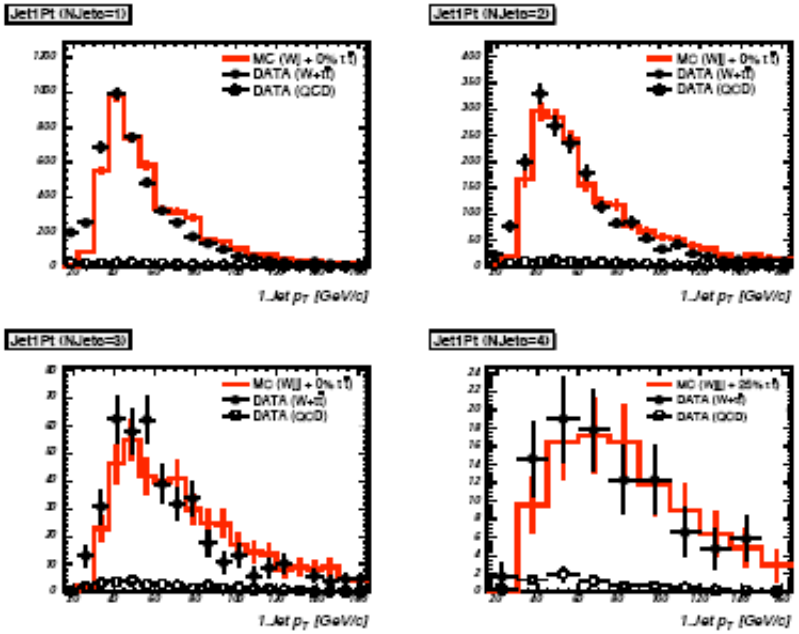
e.g., p_T^{jet1}

N_{jet}=1	N_{jet}=2
N_{jet}=3	N_{jet}=4

E+Jets



Mu+Jets

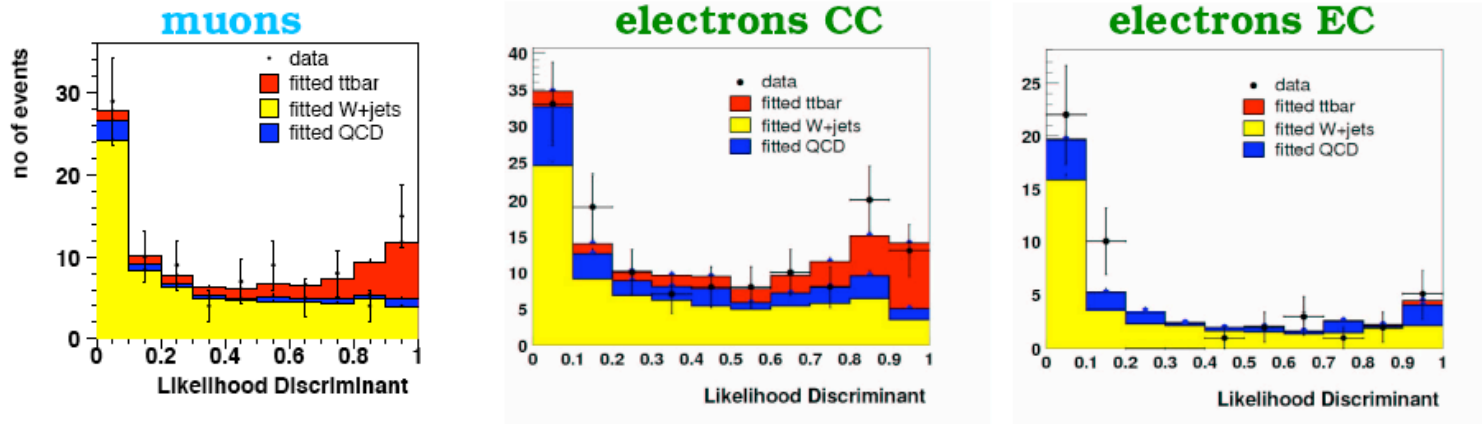


Δm (stat.) ~ 5 GeV expected - no result given so far

Top in lepton+jet channel

	muons	electrons CC	electrons EC
$N_t^{W+QCD+ttbar}$	100	136	46
fitted N_t^W	70.6 + 12.4 – 11.6	78.0 + 15.1 - 14.5	34.1 + 7.8 - 7.2
fitted N_t^{QCD}	7.0 + 0.9 – 0.8	27.6 + 2.4 - 2.3	11.0 + 1.0 - 1.0
fitted N_t^{ttbar}	22.1 + 9.9 – 8.9	30.2 + 12.4 - 11.2	0.82 + 4.5 – 0.82

Likelihoods based on scaled variables



ε_{sel}	4.6 +- 0.4 %	5.0 +- 0.2 %	0.33 +- 0.03 %
LP2003	4.2%	3.3%	n/a

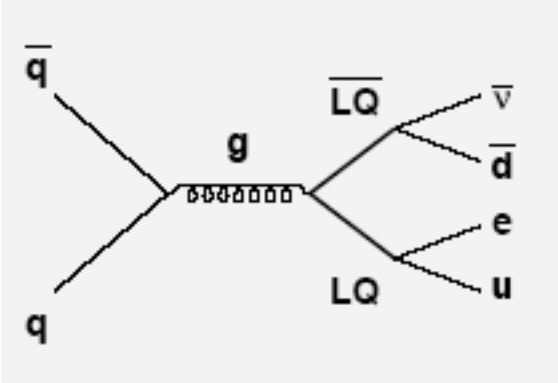
σ (muons) $= 7.5\ ^{+3.4}_{-3.0}$ (stat) $^{+x.x}_{-x.x}$ (syst) +- 0.5 (lumi) pb

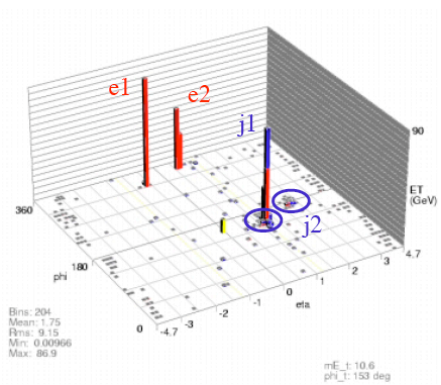
σ (electrons) $= 9.4\ ^{+3.9}_{-3.5}$ (stat) $^{+x.x}_{-x.x}$ (syst) +- 0.6 (lumi) pb

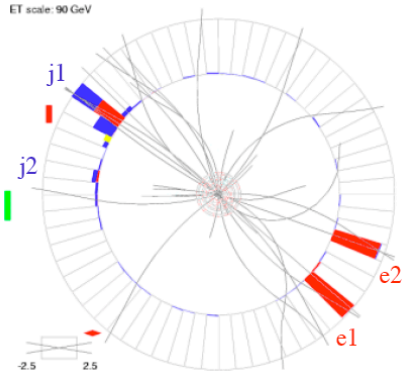
Systematics at ~15% level

Leptoquark Searches

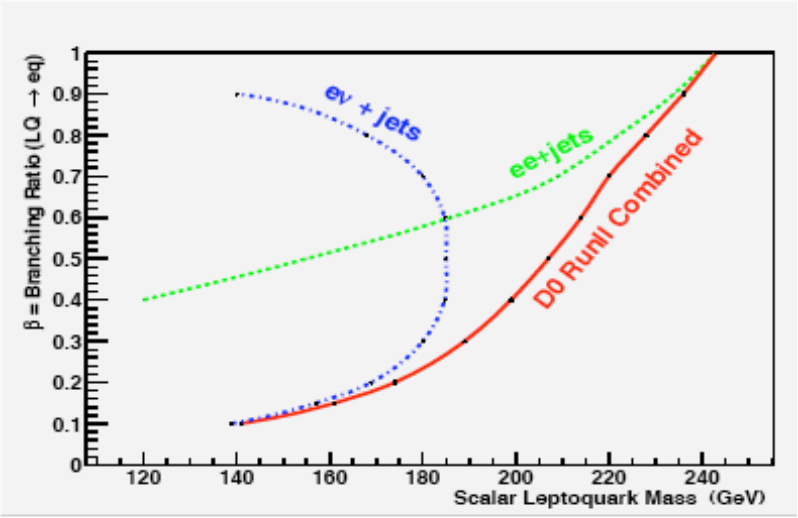
- eejj and eνjj







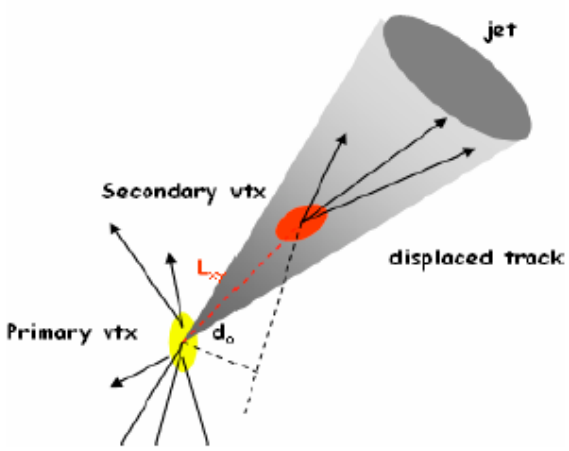
- S_T = 437 GeV
  Mee = 126 GeV; Mej = 258, 290 GeV



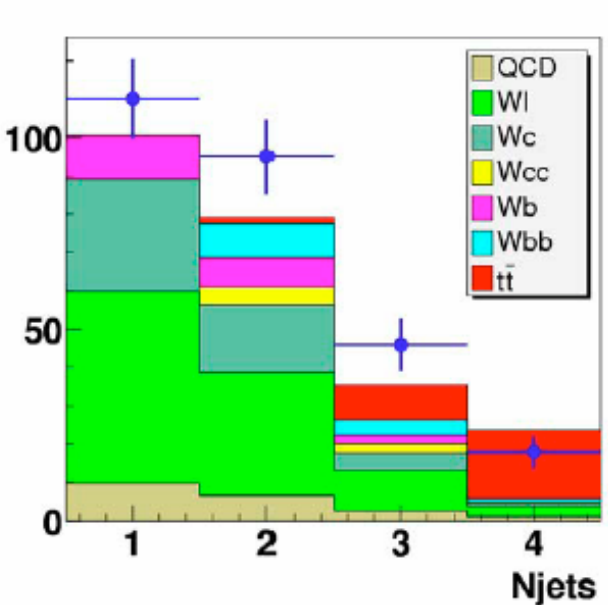
- Dominant syst. from JES
- Similar analyses nearing completion in μμjj and μνjj

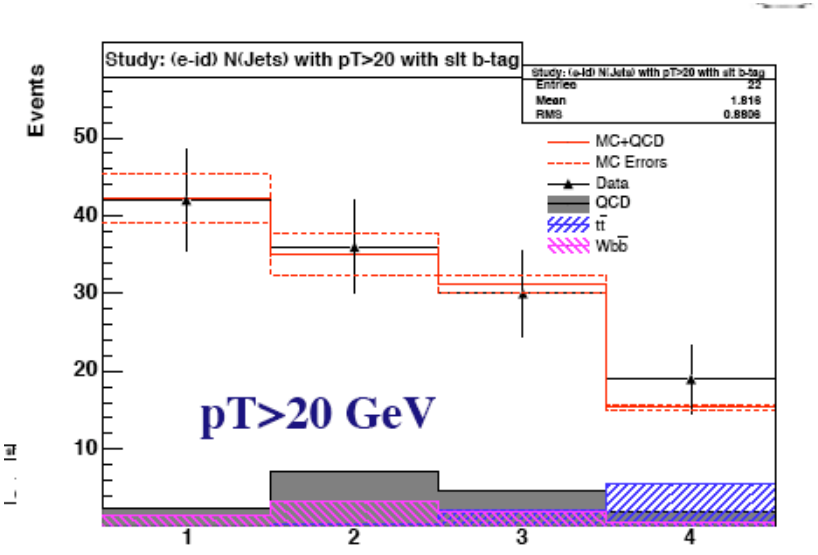
Combined Limit for β=0.5 (at 95%CL):
MLQ>207 GeV (last Summer:196 GeV)

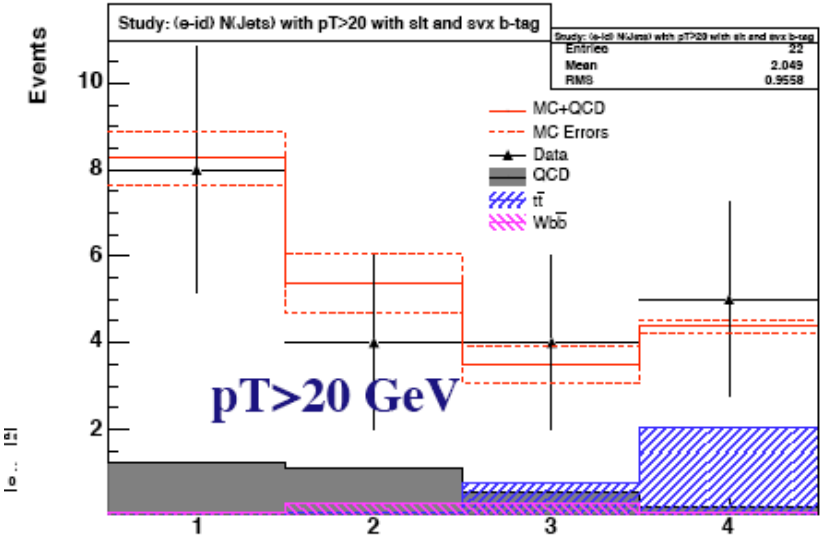
W+jets with B-tag (7 talks!)



Secondary Vertex Tag (SVT)







Top in di-lepton channel

Channel	Data	Non-top
ee	5	1.34
μμ	4	2.65
eμ	8	0.95

$$\sigma_{ttbar} = 10.89\ ^{+4.043}_{-3.319}\ (stat)\ ^{+1.859}_{-1.565}\ (sys)\ pb.$$

A Plea to Analysers

Ask not just:

What can DØ

- detector
- trigger
- reco
- computing
- data quality

do for my analysis

Ask also:

What can my analysis do for DØ

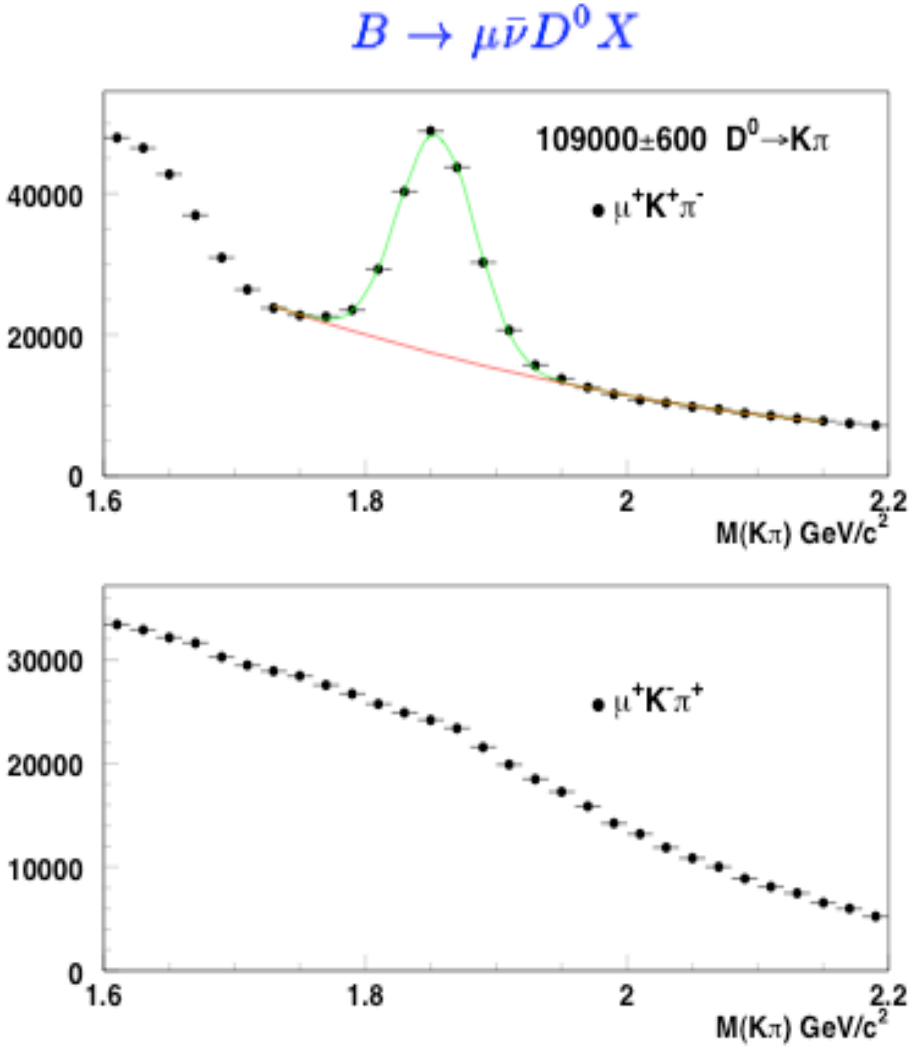
- detector
- trigger
- reco
- computing
- data quality

A Plea to Senior People

Get involved!

It's FUN having lots of data!

- Let's enjoy the next few years!



- D^0 combined with additional π^+ to give D^{*+}